1906, and the observing station. In fact this correction would be large. While no accurate measurements were made, it is thought that the difference of level on that date was about 1,500 feet. The air pressure corresponding to this difference of level would be about 0.055 of the barometric pressure above Mount Wilson. According to the pyrheliometry of August 21 and 23, 1906, we may estimate the general atmospheric transmission coefficient for August 22 as 0.90 for vertical transmission thru all the air above Mount Wilson. Hence, for vertical transmission thru the layer in question the transmission may be estimated at $(0.90)^{0.055}=0.994$.

For the very large angles of zenith distance Z, and nadir distance i, the paths of the beam in this layer ought not to be taken as simply proportional to $(\sec Z+\sec i)$, and we shall rather use the air-mass values of Laplace as given by Radau in his "Actinometrie," altho these are also of doubtful application in the present instance. Let us call the air-mass $\varphi(Z)+\varphi(i)$, where φ is a function to be taken from the above sources. Then the values of reflection given for August 22, 1906, in Table 25 of the Annals, are to be increased in the ratio

$$\frac{1}{0.994[\varphi(Z)+\varphi(i)]}$$

to allow for the difference of level. No correction of this kind is thought necessary for the values of September 13, 1906, as the cloud was practically at the level of the observer.

An entirely new set of apparatus for measuring the reflecting power of clouds is now in place at Mount Wilson, and we hope to obtain a great many additional measurements there this year. We therefore refrain from computing at present a new value of cloud reflection and of the albedo of the earth from the observations of 1906.

EARLY METEOROLOGY AT HARVARD COLLEGE. 2.

By B. M. VARNEY, Assistant in Meteorology. Dated Cambridge, Mass., September 10, 1908.

In a recent article[1] on the early history of meteorology at Harvard College the writer mentioned the announcement of lectures by Isaac Greenwood, the first Hollis Professor of Mathematics and Natural Philosophy. While the strictly meteorological subjects comprise but a small part of this announcement, and therefore presumably of the lectures, it is probably one of the oldest extant records of scientific lectures in this country and thus has considerable historical interest. A few pertinent historical notes which the writer has been able to gather follow the "Syllabus." The absence of a full text of the lectures and of contemporaneous accounts of them renders a detailed study impossible.

A

Course of Philosophical Lectures,

with a great Variety of

Curious Experiments,

Illustrating and *Confirming*

Sir ISAAC NEWTON'S *Laws*

OF

MATTER AND MOTION.

By ISAAC GREENWOOD, *A. M., &c.*

ARTICLE I.

Of the FUNDAMENTAL PRINCIPLES *of* MATTER

Where the essential Properties *of* Space *and* natural Bodies, *are shewn, in a great variety of* Experiments: *And the* NEWTONIAN LAWS of Matter *demonstrated.*

I. *Of the* ESSENTIAL PROPERTIES *of Space and* natural Bodies.

LECTURE I.

OF EXTENSION—The Manner of *Conceiving* and the *real Proof* of a *Vacuum*, by several *curious Experiments*—The *inconceivable Divisibility* of the Parts of Matter, shewn in *natural* and *artificial Instances*, by a Sett of *microscopical Observations*, and prov'd by Dr. *Neiuwentyt's Experiment* of the *Division* of Water, by the *Ælopile;* on which *Principle* the *Operation* of the celebrated *Engine to raise Water by Fire*, will be explained in a very large *Cutt* thereof.

Lecture 2. Of the SOLIDITY and POROSITY of *natural Bodies* in many *useful Experiments* and *critical Remarks*; where particular Notice will be taken of the *Alterations* they are subject to by *Heat* and *Cold*, *Dryness* and *Humidity*, *Weight* and *Levity*, in many *curious Experiments*. And of the STRUCTURE and FORMS of *natural Bodies*,—their *inward Disposition*,—*external Configuration*, with a Variety of *Experiments* relating to the *Changes* of their *Forms* on many Considerations.

II. *Of the* NEWTONIAN LAWS *of* MATTER.

Lecture 3. Of the *Fundamental* LAW; viz. GRAVITY or GRAVITATION, (where all its *Properties* will be *very particularly* illustrated and confirmed) together with the other two *General Laws*; viz. the COHÆSION and REPULSION existing between the *minute Parts* of *Matter*, in a great Variety of *Experiments*.

Lecture 4. Of the SPECIAL LAWS of MATTER; viz. MAGNETISM and ELECTRICITY; where their *surprising* and most curious *Phænomena* are shewn in a Sett of very useful and *delightful Experiments* of *late Invention*.

ARTICLE II.

Of the FUNDAMENTAL PRINCIPLES *of* MOTION.

I. *The* Principals *of* MECHANICS.

Lecture 5. *Explanations* of *necessary Terms*, with many *Experiments* relating to the *Places* of the *mechannic Centers* of Bodies, their *Velocities*, *Quantities of Matter*, and *Momenta* of *Motion*.—The *Fundamental Propositions* relating thereunto, proved on proper *Machines*—*Experiments* about the *falling*, *sliding*, and *rolling* of *Natural* Bodies, &c., very *curious*; the *Solution* of several entertaining *Problems*, relating to *Animal Motion* and *Action*; with a Conclusion concerning the Explanation of the *Motion* of the *Astronomical Bodies* on these *Principles*.

Lecture 6. A full *Explanation* with many *Experiments*, on the *Five Mechanical Powers* or *Simple Machines*; viz. the *several Kinds* of *Ballances*, *Levers*, *Pullies*, *Wheels* and *Axles*, *Wedges* or *Screws*; of *Compound Machines*; and the *Invention* and *Use* of many *useful* and *curious Engines*.

II. *Of the* NEWTONIAN STATICS.

Lecture 7. Of *absolute and relative motion.*

Sir ISAAC NEWTON'S

1. *Law of Motion*, viz. *That all Bodies continue in the State of Motion or Rest, uniformly, in a right Line, except so much as that State is Chang'd by Forces impress'd*; with many *Examples* and *Experiments*; Of the great Use thereof in the *Motion of Bodies* proceeding from *single* and *Compound Impulses*. Of the *Phænomena* of *Diagonal Motion* and *oblique Powers*.

2. *Law of* Motion, viz. *That the Change of Motion is always proportional to the moving Force impress'd; and is always made in the right Line in which that Force is impress'd.* Of the *Phænomena* of *Accelerated* and *Retarded Motion*.

Of Projectile Motions.

Lecture 8. Of *oblique Descents*; where all the curious *Experiments* and *Observations* relating to *Pendulums* and their *Uses*, will be made. Of *Circular* and *Elliptical Motion*, with many *Experiments*. Dr. *Desagulier's* celebrated *Experi-*

[1] See Monthly Weather Review, May, 1908, XXXVI, p. 140.

ment, proving the *oblate Figure* of the *Earth*, from its *Diurnal Motion*.

Lecture 9. 3d *Law of* Motion, viz. *That the Actions and Reactions of Bodies upon one another are equal and in contrary Directions*. (1) Of the various *Phænomena* consequent upon the *Congress* or *Percussion* of *Natural Bodies*. (2) Of the *Doctrine* of Elasticity; where will be performed many curious Experiments concerning *Elastic Substances*: With an Application of the *Principles*, thence deduced, to explain the *Nature* of *Sound* and the *Theory* of *Music*; particularly of the Experiments of the *Division* of the *Monochord* and the Proportions of the Diameters of *Harmonic Chords* to produce any *Musical Notes*—of the *Scale of Music*—Effects of *Music* on *Natural Bodies*—of the Echo &c.

ARTICLE III.

Of the TRUE CAUSES of the PRINCIPLE PHÆNOMENA *in Nature, by Means* of the *Newtonian Laws* of MATTER and MOTION.

Lecture 10. (1) *A View of the World around us subject to these Laws* shewn on very good *Schemes* and *Instruments*; which [with?] an Account of Mr. *Professor Bradley's* new *discovered Motion* of the *Fixt Stars*.

(2) An *Enumeration* of the *Phænomena* in the SOLAR SYSTEM—*Effect* of Sir ISAAC NEWTON'S *Laws* of GRAVITATION, with his *Account* thereof.

Concerning which, *several curious Experiments* illustrating the *Nature* and *Reason* of the *Planetary* and *Cometary* Motions, the *Alterations* they are subject to, their *mutual Actions* &c., will be performed.

Lectures 11, 12. (3) *Of the Effects of* GRAVITATION, as to the *Earth*, in particular.

Of the *Fundamental Principles* with many Experiments relating to FLUIDS, HYDROSTATICAL and PNEUMATICAL.

Of the *Action* of the *Sun* and *Moon* upon the *Atmosphere*, and *Bodies* contained therein.

Of the *Action* of the *Sun* and Moon on the *Oceans* and *Seas*; *where* the NEWTONIAN *Doctrine of Tides* will be particularly illustrated and confirmed by Means of several proper *Machines* and *Schemes*.

Experiments of the Pendulous *Motion* of Waves.

Of the CONSTANT CURRENT of all *Oceans*, Eastward—a *Discovery* never yet made *public* with its true *Cause* and *Effects*.

(4) *An Enumeration* of the *principal Phænomena,—Effects* of SIR ISAAC NEWTON'S other *Laws of Nature*, viz, COHÆSION, REPULSION, MAGNETISM and ELECTRICITY.

Where, with many other *Curiosities*, a *particular Consideration* will be taken of Dr. *Desaguliers* late *Theory* of the *Rise* of *Vapours* and *Formation* of *Clouds*, and *Meteors*, with his Experiments concerning them.—Dr. *Halley's* Account of the *Aurora Borealis* with his *Experiments*—Mr. *Gray's* new *Discoveries* as to *Electricity* &c.

N. B. Some *Entertaining Things* will be shewn, during the Course, with the *Magic Lanthorn, Camera Obscura*, good *Telliscopes, Microscopes*, &c. that fall not properly under any of the foregoing Heads.

The *Apparatus* is compleat for the *Experiments*, and will be *inlarged* with new *Machines* and *Models* of some *curious Engines*, lately invented, if there be a *full Course*.

CONDITIONS.

Every *Subscriber* to pay *Four Pounds, One* at the Time of *Subscription* and the *Remainder* on the 3*d* and 6*th Day* of the *Course*.

This Course to begin on ——— Instant, at —— o'Clock in the —— noon, and to be continued afterwards on what Days and Hours best suits the Company.

Isaac Greenwood was born in May, 1702, probably at Boston, Mass., since his father was a resident of that city. He was graduated with the Harvard class of 1721, studied for the ministry, and visited England, where, as we are told, he "began to preach in London with some approbation." He became a pupil of Desaguliers, and the pursuit of scientific studies resulted in his leaving the pulpit. Eventually he persuaded Thomas Hollis, a London merchant, to establish a science professorship at Harvard College, and he was appointed the first occupant of the chair.

According to the "Rules and Orders" stipulated by Hollis, the duties of the holder of this professorship, outside of his regular college lectures, were:

3. That the Professor shall read once a week and when ever the Corporation with the approbation of the Overseers shall require it twice a week (Times of vacation excepted) publickly in the Hall to all students that will attend on such topics relating to the Science of the Mathematics Natural or Experimental Philosophy as he shall judge most necessary & usefull but always distinct or different from his private lectures.

It still remains uncertain whether or not these lectures delivered publicly to students were those announced in the Syllabus reproduced above. They were, however, "different from his private lectures." The statement made in my previous paper, regarding this, may therefore need qualification.

On February 5, 1727, the Corporation of Harvard College

Voted: yt Coll. Hutchinson & Mr. Sever be desired in the name of ye corporation, to wait on his Honr ye Lieutenant Governour, to know when it will suit his Honr to afford his Presence at ye Installment of Mr. Isaac Greenwood Hollisian Professor of ye Mathematicks & to appoint a meeting of ye Honble & Revnd overseers at ye College for yt purpose.

His Honor lost no time, as the following press-notice[2] shows:

Mr. Isaac Greenwood was inaugurated at the College Hall in Cambridge into the office of the Professor of Mathematicks and Natural and Experimental Philosophy lately founded by that great and living Benefactor to the Society, Mr. Thomas Hollis of London, merchant. And we hear Mr. Greenwood gave his first public lecture at the College Hall on Wednesday last, Feb. 7.

The institution of a professorship in natural science at a college where the classics had from the first formed a major part of the curriculum, probably caused more stir in Boston and Cambridge than the quotation implies.

It was, of course, almost inevitable that Professor Greenwood's lectures should in general follow the order of treatment of the various mechanical powers and natural phenomena as given in the Course of Experimental Philosophy of his great English teacher, who in turn had his inspiration from Sir Isaac Newton. Desaguliers (born of French parents in 1683, at La Rochelle, France) was elected a member of the Royal Society in 1714 (Isaac Newton was then president), and was invited to become its demonstrator and curator. He is said to have been the first to deliver lectures on scientific subjects to the general public—a fact which renders it more than likely that Greenwood's lectures were the first on similar subjects in the United States. Desaguliers' lectures were attended by the most learned men of his day, and were made interesting by skilful experiments. He contributed voluminously to the Transactions of the Royal Society.[3]

It is probable that Greenwood made use of Desaguliers's teachings and experiments further than simply to discuss his theory of the rise of vapors and formation of clouds. On this theory, definitely meteorological in its interest to us, its propounder writes as follows:[4]

Now may not this phaenomenon of the rise of vapors depend upon electricity in the following manner?

The air which flows at the top of the surface of the waters is electrical, and so much the more as the weather is hotter. Now in the same man-

[2] New England Weekly Journal, February 13, 1727.

[3] A brief account of his life, and a full list of his works is contained in the "Dictionary of National Biography."

[4] Phil. Trans. Roy. Soc., Vol. XLII, p. 142.

ner as small particles of water jump toward the electric tube, may not those particles jump toward the particles of air, which have much more specifi·· gravity than very small particles of water, and adhere to them? Then the air in motion having carried off the particles of water, and driving them away as soon as it has made them electrical, they repel one another, and also the particles of air. This is the reason that a cubic inch of vapour is lighter than a cubic inch of air; which would not happen if the particles of vapour were only carried off in the interstices of air, because then a cubic inch of air, loaded with vapour, would be made specifically heavier than dry air; which is contrary to experiments, which show us by the barometer, that air which is moist, or full of vapours, is always lighter than dry air."

In the Course of Experimental Philosophy just quoted, Desaguliers pays much attention to the barometer, especially to its construction according to various patterns, and gives at considerable length the substance of Halley's "Discourse Upon the Reasons of the Rise and Fall of the Mercury in Fair and Foul Weather."[5] To one interested in the history of the barometer, the thermometer, and the hygrometer, there are many pages of fascinating reading in Desaguliers' book.[6]

The Doctor Halley mentioned by Greenwood in connection with his twelfth lecture, on the aurora, was the astronomer Edmund Halley. Greenwood probably referred to his Account of an Aurora Borealis seen at London, November 10, 1719[7]. Altho Halley's fame rests chiefly on his work in astronomy and mathematics, he wrote much on purely meteorological subjects. The following list, tho possibly not directly connected with Professor Greenwood's lectures, is interesting for the light it throws on early meteorology in England. Maty's Index to the Philosophical Transactions of the Royal Society gives the volume and page for each contribution.

A discourse of the rule of the height of the mercury in the barometer.

An historical account of the trade-winds and monsoons (published in 1686).

An estimate of the quantity of vapour raised out of the sea by the warmth of the sun.

An account of several experiments made to examine the nature of the expansion and contraction of fluids by heat and cold, in order to ascertain the divisions of the thermometer, and to make that instrument in all places, without adjusting it by a standard.

On the proportional heat of the sun in all latitudes, with the method of collecting the same.

An account of the evaporation of water, as it was experimented in Gresham College, in 1693, with some observations thereon.

An account of the Torricellian experiment, tried on the top of Snowdon-Hill, and the success of it.

An account of Dr. R. Hook's invention of the marine barometer, with its description and uses.

Doctor Neiuwentyt, or Neiuwendijdt, named in connection with the Aeolopile (Lecture I), was a Dutch philosopher, born in August, 1654, and died in May, 1718. He was rather a famous physician in his day.

Mr. Greenwood's tenure of the Hollis professorship came to an early end in 1738, and he died prematurely seven years later at Charleston, S. C. His successor was Prof. John Winthrop.

JOHN WINTHROP'S LECTURES.

While Greenwood's Syllabus contains the first printed announcement of lectures at Harvard College, Winthrop's Summary of a Course of Experimental and Philosophical Lectures is the earliest known record of the text of such lectures, and probably the first of scientific lectures in this country. Only a small section of them dealt with meteorology, strictly so called. It has seemed best to bring this section out of the seclusion of the original manuscripts and to present it in full to the meteorological public. The old spelling as given in the manuscripts of the "Summary" and of the "Meteorologic Diary" has not been retained here.

Lecture 21st. April 26. [*1746.*]

We have already considered incompressible fluids, we now come to speak of compressible ones; tho air be the only one we know of. This air is a fluid lighter than any one we know of; and it encompasses the whole earth. When considered altogether it is called the atmosphere. Air has gravity, for by its pressure it will sustain water in a tube 35 feet and mercury 30 inches. The Torricellian experiment (so called from its inventor) is made with a tube sealed at one end and filled with mercury; then inverted into a basin of the same, it remains suspended at a height of 30 inches. This is called a barometer, and serves not only to show—

1. That there is a pressure of the air—but
2. To show the quantity of that pressure—and
3. To show that the pressure is different at different times—and also
4. To measure the heights of mountains and the depths of mines—and
5. This barometer rises in serene, fine and pleasant weather, and falls in foul and is lowest in stormy;

It is highest when the wind is in the northern board and the greatest variation is in winter and vice versa, all which arises from the different pressure of the air,—The pressure of the air on every square inch is = to 15 weight for a cubic inch of mercury weighs about 1/2 a pound: and by this computation is the whole atmosphere = in weight to a globe of lead of 60 miles diameter. And the pressure of it on a human body 30,000 pounds by the same computation. The greatest variation of the barometer is 3 inches, from 28 to 31. But in this country the greatest is 2 inches and 1/2 or from 28 3/4 to 30 3/4.—Now tho the mercury does not press the bottom of the tube it weighs as much as if it did; for its action against the side of the tube is horizontal, but the weight of the air sustained by the tube being equiponderate to the column of mercury in the tube; you in effect weigh only the atmosphere and tube instead of the mercury and tube. The air is elastic and perhaps more so than any other body whatsoever; for putting a bladder into the air pump 1/2 blown, the air in it expands and swells the bladder to the utmost extent; which was proved experimentally.

Near the end of the twenty-fifth lecture we find this:

The heat of the air is measured by a thermometer as gravity is by the barometer. Thermometers are of different kinds; as of air which forces water up into a tube by its elasticity, but it will never answer the end, because it's a barometer and thermometer too. They have till lately been made of spirits of wine; but those made of mercury are esteemed the best because they are most easily affected. There are some made of oil. Sir Isaac [Newton] made one of linseed oil and by this means measured the degree of heat in melted metals; the moisture and drought of the air is measured by an hygrometer which is made just as one fancies, but the most common are those made of a cord and a weight at the end of it. Some are made with cords and an index that turns with it.

At the close of the last lecture, the thirty-third, is written this:

This course of experimental and philosophical lectures, was concluded on the 16. of June 1746, by Mr. John Winthrop, Hollisian Professor of the mathematics, natural and experimental philosophy at Harvard College.

JOHN WINTHROP'S OBSERVATIONS.

Turning now from his public to his private meteorological work we find that Professor Winthrop was evidently a keen observer of the weather, aside from the mere taking of observations; and was interested in giving to the public, accounts of noteworthy meteorological events. Of these accounts only two appear to have been preserved. The following letter[8] tho unsigned, was undoubtedly written by Professor Winthrop, inasmuch as the temperatures given appear under their proper dates, in his Meteorologic Diary.

Cambridge, January 30, 1765.

Messirs Drapers,

As the weather of late has been extremely cold, some of your readers may probably be gratified with an account of the degree of it, as estimated by one of Fahrenheit's thermometers.

On the 9th instant, at	IX 1/4 M. it was	5
27th	VIII 3/4	4
28th	IX	9
29th	VIII 1/4	8

By this thermometer, there have been but four colder mornings than the 27th since the year 1708. The coldest of all was on the 12th of January 1752 at VIII M; when the mercury was 1/2 a degree below the point marked 0. On January 22, 1754, at VII 3/4 M, it was 3 degrees above 0. On January 18, 1757, at IX 1/2 M, it was 2 1/2 d. and on December 24, 1761, at IX 1/4 M, it was but 1 d. above 0.

Such a degree of cold, however severely felt by us, and sufficient to congeal our rivers and bays, is as nothing to what has been observed in other parts of the world. Travellers inform us that in Siberia, at the

[5] Original in Phil. Trans. Roy. Soc., Vol. XLII, p. 187.

[6] Barometer, p. 262–280, 303–306; Thermometer, p. 289–298; Hygrometers or "Notiometers," p. 298–302.

[7] Phil. Trans. Roy. Soc. Vol. XXX, p. 1099.

[8] Massachussetts Gazette, January 31, 1765.

end of June the earth has been thawed only to the depth of 3 feet, and below this has been found frozen to a great depth. 'Tis said, that in the summer of the years 1685 and 1686, in digging a well they got to a depth of 91 feet, and found the earth frozen hard all the way. And the cold has sometimes been so great, that with the help of freezing mixtures they have been able to fix mercury itself.

Your's, &c.

In the Proceedings of the Royal Society, Vol. LII, pt. 1, p. 6, appears "An account of a meteor seen in New England, and of a whirlwind felt in that country, July 10, 1760," contributed by Professor Winthrop. It deals first with a meteor that fell in southern Massachusetts, "by which the southern parts of the province were greatly alarmed," and then with the tornado. The account of this latter is very detailed, particularly as to the damage done. A careful description of the positions occupied by uprooted objects after the passage of the storm, leads the reader to expect an explanation of the cause of the whirl, none is given, however, and Winthrop closes his article thus:

It appears to me so difficult to assign a cause adequate to these effects, to show by what means a small body of air could be put into a circular motion, so excessively rapid as this must have been, that I dare not venture any conjectures about it.

The desultory accounts and observations above mentioned sink into insignificance when one opens the manuscript pages of Professor Winthrop's Meteorologic Observations, or, as he sometimes wrote it, Meteorologic Diary. These observations occupy three quarto volumes, each about 1½ inches thick. They cover in all no less than thirty-six years in an all but unbroken series, from December 11, 1742, to December 31, 1778. The "chasms," as he called them, aggregate barely two months of the entire time. This remarkable record, while by no means the first of its kind in this country and while possibly somewhat less accurate, because of faulty exposure of the instruments, than that of Doctor Lining at Charleston, S. C.,[9] has the distinction of being, by seventeen years, the longest continuous record kept by one person prior to 1800. Winthrop's own account[10] of his instruments, their exposure, the tables of observations, etc., as found at the end of the first year's record, is here given, nearly in full. It shows him to have been a careful scientist, tho, as appears from the text, he did not venture into the field of speculation. Meteorology in his day was still largely a matter of tabulation.

The [foregoing] diary is divided into 5 columns. The 1st shows the day and hour of the observation; the morning hours or those from midnight to noon being marked M; and the evening hours or those from noon to midnight being marked E.

The 2d column contains the height of the barometer in English inches and decimals. . . . I made use of a common or open barometer which I filled and inverted very carefully so as to clear it of air as effectually as I could. The diameter of the bore of my tube is .27 of an inch and the diameter of the cistern in which it is immersed is 3 inches. . . .

My thermometer was of Mr. Hawksbee's make, filled with spirits of wine. The scale is divided into 100 equal parts beginning from a certain point above marked 0 and the 100th degree falls just above the bulb of the thermometer. The freezing point is numbered 65; and the divisions are continued upwards to 8 degrees above 0. The observations are expressed in these degrees, with their decimal parts. For want of a northern room, I placed the thermometer in a chamber looking westward, where no fire was kept, and from which I excluded the sun by window shuts. But to open a communication with the external air I made a hole through the side of the house in such a manner, however, that the sun could never shine through it. So that I believe the thermometer was always nearly in the same temperature of the air as if it had been placed abroad. By the diary it appears, that though the thermometer was capable of showing the greatest heat we had last year, it would not show the greatest cold; the spirits several times subsiding so low as to be quite invisible, which in the diary is marked 101+, as the degrees of height above 0 are marked with the negative sign. . . . I shall be enabled for the future to observe greater degrees of cold by the help of a mercurial thermometer given me last winter by Colin Campbell, Esq., F. R. S., that ingenious member of the Royal Society, who misses no opportunity of promoting natural knowledge. It was made by Samuel Bewley opposite to St. Martin's Church, London, and is graduated according to Fahrenheit's scale. The divisions go upwards from the point marked 0 near the bottom of the tube as far as 112, which is called *seventh heat*, and the freezing point is number 32, and is, I think, justly placed, for having put the thermometer into snow the mercury stood at that point. Having put this thermometer close by the former, I observed in an intense cold that when the spirits of wine stood at 100, the mercury was at 16. The latter thermometer will therefore seem to estimate much greater degrees of cold than the former, and perhaps the greatest cold of this climate.

In the column of winds, I have followed Mr. Locke and Doctor Jurin, denoting the strength by the numbers 1, 2, 3, 4 and making use of a cipher, 0, to indicate a perfect calm.

I use *clear* to signify that the sky was entirely free from clouds. *Very fair* when it was almost clear, and few clouds to be seen. *Fair*, when more of the sky was free from clouds than not. *Fair with clouds*, when it was uncertain whether more of the sky was covered or clear. *Cloudy*, when more of the sky was covered with clouds than not. *Very cloudy*, when it was almost but not quite covered. *Covered*, when no part of the clear sky appeared. *Close*, when the sky was covered with one uniform thick cloud.

I would willingly have observed the quantity of rain, snow and other vapors that fell here; but my lodgings were so circumstanced that it was impracticable.

Whenever a dash is found in any column of the diary, it is to be understood that matters continue in the same condition as in the preceding observation. The chasms noted with dots, to be met with here and there were occasioned by my absence from Cambridge.

At the end of every month and every year I have set down the mean altitude of the barometer, as also that of the thermometer for morning and evening, found by dividing the sums of those altitudes by the number of observations.

I shall not pretend to make any remarks on the diary, which I know may be done to much greater advantage by any member of the illustrious Royal Society, who shall think it worth while to look over the same.

Cambridge, New England,
9 March 1744.

Following a description of a new exposure of his instruments occasioned by a change of residence, he writes:

I have always endeavored to set down the least height of the thermometer in the morning, and its greatest height in the afternoon, which is the reason why the observations are not always made at the same hour. And where there occur more than two observations in a day one of them is for the sake of the barometer, which was either higher or lower then than in the immediate foregoing or following observations.

At the end of each year are given the following tables:

1. A table of the mean, greatest, and least heights and ranges of the barometer for the year — at Cambridge, New England.
2. A table of the morning and evening heights, and of the greatest and least heights of Hawksbee's thermometer, for the year —.
3. The same for Fahrenheit's thermometer,
4. A table of winds, showing the number of observations of their blowing for each quarter of the horizon, being N to EbyN, inclusive, etc., for the year —.

Professor Winthrop's naively hinted desire for the keeping of a rainfall record was first gratified in August, 1749, from which time he kept a continuous record thru the year 1775. In 1779, the year of his death, he went back over the long record, and tabulated in the Hawksbee scale, the mean monthly temperature of each year from 1753 to 1779. He did the same for the rainfall, entering his results under "Rain from 1750 to 1776," which table he divided into "Synopsis of Rain, etc., in inches and millesimals," and "Means of Rain, etc." (This latter part from January, 1765, to December, 1773, inclusive) He recognized the unreliability of short-period averages, as is shown by his allowing fifteen years after the beginning of his rainfall observations before taking the means. The rainfall tables are here given, in full, as Tables 1 and 2. The year of maximum and minimum precipitation for each month, Professor Winthrop indicated by *W* and *D*, respectively. In the original, the ten-thousandths are exprest as common fractions.

It is remarkable that nothing remains to show that Professor Winthrop carried on an extensive correspondence with Benjamin Franklin,[11] who numbered among his varied interests

[9] See A. J. Henry: Early Individual Observers in the United States. U. S. Weather Bureau Bul. 11, p. 291 et seq.

[10] From manuscript in possession of the American Academy of Arts and Sciences. Boston, Mass.

[11] The list of the Benjamin Franklin papers in the Library of Congress, published in 1905, mentions but four letters, one of which was not to Winthrop, himself; two were from Franklin to Winthrop and one from Winthrop to Franklin.—*C. A., jr.*

TABLE 1—*Prof. John Winthrop's record of precipitation at Cambridge, Mass., from 1750 to 1775, inclusive.*

Year.	Synopsis of rain, etc., in inches and millesimals.														Remarks.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly quantities.	Means, as they arose.	
1750....	2.355	0.708	3.894	4.063	3.651	3.076	4.235	9.464	2.145	2.721	2.084	3.835	42.281	....	Wettest month was July, 1758.
1751....	4.143	6.944	2.573	3.222	2.486	6.734	5.2	W 9.475	4.144	3.157	3.08	1.928	53.086	47.6585	
1752....	2.077	3.056	4.808	2.646	1.263	5.341	4.934	1.326	0.875	7.122	1.878	3.066	38.392	45.56966	Order of months as to wetness at ——:
1753....	3.809	3.745	3.782	2.138	3.647	W 7.766	3.467	3.855	2.707	W 8.817	5.116	3.177	52.026	46.43375	
1754....	4.342	3.218	3.223	1.306	3.914	7.157	7.139	2.689	D 0.346	3.478	5.72	3.949	46.481	46.4432	
1755....	3.718	3.665	4.324	3.327	2.506	2.216	4.775	1.334	2.3	4.163	4.71	1.47	38.503	45.12066	*Dry.* *Wet.*
1756....	3.636	0.807	2.188	3.618	2.51	4.948	2.753	2.644	1.315	5.996	4.341	1.695	35.461	43.74071	September. December.
1757....	4.773	5.241	5.007	3.506	D 0.895	1.008	4.299	4.177	1.652	3.644	2.984	4.148	41.334	43.43987	April. November.
1758....	W 7.194	3.04	2.126	1.54	3.078	5.638	W 9.83	7.584	1.212	4.14	4.165	4.179	W 53.726	44.58277	March. June.
1759....	2.492	4.074	2.772	2.287	2.362	5.083	5.421	7.796	4.233	4.956	4.893	2.549	48.918	45.0163	May. August.
1760....	2.501	1.674	1.537	1.237	4.01	4.259	D 0.849	5.098	6.336	2.822	2.789	5.877	38.984	44.4679	February. October.
1761....	0.745	1.334	D 0.895	1.899	W 4.88	0.899	1.54	2.489	4.075	3.93	3.13	W 6.509	31.825	43.41438	January. July.
1762....	4.127	0.942	1.501	1.466	2.131	0.888	1.755	2.736	0.892	6.018	D 0.665	1.35	D 24.466	41.95715	
1763....	1.924	3.345	2.694	2.622	4.836	3.062	6.399	2.41	1.06	3.445	4.784	3.597	39.678	41.794	450.163 in 10 years.
1764....	D 0.047	3.871	1.405	4.494	1.898	1.747	6.054	2.168	4.393	3.204	3.565	4.581	36.927	41.4695	
1765....	1.918	D 0.596	2.891	4.017	2.668	2.566	2.738	7.783	1.422	3.085	3.856	3.113	32.653	40.9135	
1766....	1.749	0.938	4.032	3.737	3.187	2.405	5.848	4.373	2.772	5.324	1.641	1.726	37.732	40.73105	
1767....	3.338	1.006	5.386	2.712	2.922	1.595	6.178	1.639	5.727	2.354	5.156	4.302	42.315	40.81905	
1768....	2.792	2.069	1.476	D 1.23	2.538	3.322	4.269	4.811	5.66	3.046	2.184	4.357	36.754	40.6051	
1769....	1.989	1.753	3.563	1.868	3.08	D 0.753	4.208	D 1.033	4.333	D 1.825	5.915	D 1.078	31.393	40.1445	
1770....	4.247	3.153	1.062	1.636	4.03	3.523	1.392	8.851	3.718	5.307	3.171	1.187	41.272	40.1982	
1771....	2.557	W 6.975	W 6.298	4.17	4.073	3.91	3.03	1.768	2.19	2.484	5.669	2.186	45.31	40.4306	802.89 in 20 years.
1772....	1.75	4.383	2.059	W 4.92	2.279	1.807	3.959	6.863	W 7.648	6.63	3.555	3.022	48.875	40.79769	
1773....	2.788	1.218	2.794	2.312	2.256	1.912	2.731	2.555	2.938	4.009	1.959	5.142	32.614	40.4566	
1774....	2.461	1.887	2.631	2.807	3.877	3.285	2.165	3.922	3.175	2.46	W 6.288	2.396	37.353	40.3326	
1775....	0.857	1.056	0.991	....	....	....	....	....	....	....	....	....	....	....	

TABLE 2.—*Prof. John Winthrop's summary of his record of precipitation at Cambridge, Mass.*

	Mean quantities of rain, in inches and millesimals.											
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Mean quantities of 15 years	3.1922	3.01	2.8486	2.6243	2.8711	3.9876	4.5766	4.349	2.5123	4.4412	3.5936	3.461
Total of 15 years	47.883	45.164	42.729	39.371	43.067	59.816	68.65	65.245	37.685	66.619	53.904	51.91
1765	1.918	0.596	2.891	4.017	2.668	2.566	2.738	3.783	1.422	3.085	3.856	3.113
Total of 16	49.801	45.76	45.62	43.388	45.735	62.382	71.388	69.029	39.107	69.704	57.76	55.023
Means	3.1125	2.06	2.85125	2.71175	2.8585	3.8987	4.46175	4.314	2.4442	4.3565	3.61	3.438
1766	1.749	0.938	4.032	3.737	3.187	2.405	5.848	4.373	2.772	5.324	1.641	1.726
Total of 17	51.55	46.698	49.652	47.125	48.922	64.787	77.236	73.401	41.879	75.028	59.401	56.749
Means	3.0323	2.746	2.9206	2.772	2.87766	3.811	4.5433	4.3176	2.4635	4.4134	3.4942	3.3382
1767	3.338	1.006	5.386	2.712	2.922	1.575	6.178	1.639	5.727	2.354	5.156	4.302
Total of 18	54.888	47.704	55.038	49.837	51.844	66.382	83.414	75.04	47.606	77.382	64.557	61.051
Means	3.0493	2.6502	3.057	2.7686	2.8802	3.6878	4.6341	4.1688	2.6448	4.299	3.5865	3.3916
1768	2.792	2.069	1.476	1.23	2.538	3.322	4.269	3.811	5.66	3.046	2.184	4.357
Total of 19	57.68	49.773	56.514	51.067	54.382	69.704	87.683	78.851	53.266	80.428	66.741	65.408
Means	3.0353	2.6913	2.9744	2.6877	2.8622	3.6686	4.6149	4.150	2.8035	4.23305	3.5126	3.4425
1769	1.989	1.753	3.563	1.868	3.08	0.753	4.208	1.033	4.333	1.825	5.915	1.078
Total of 20	59.669	51.526	60.077	52.935	57.462	70.457	91.891	79.884	57.599	82.253	72.656	66.481
Means	2.9835	2.5763	3.0039	2.64675	2.8731	3.5228	4.5945	3.994	2.8795	4.1126	3.6325	3.32405
1770	4.247	3.153	1.062	1.636	4.03	3.523	1.392	8.851	3.713	5.307	3.171	1.187
Total of 21	63.916	54.679	61.139	54.571	61.492	73.98	93.283	88.735	61.312	87.56	75.827	67.668
Means	3.0433	2.6035	2.0114	2.5983	2.9282	3.5228	4.4425	4.2255	2.9195	4.1695	3.6107	3.22225
1771	2.557	6.975	6.298	4.17	4.073	3.91	3.03	1.768	2.19	2.484	5.669	2.186
Total of 22	66.478	61.654	67.437	58.741	65.565	77.89	95.313	90.503	63.502	90.044	81.496	69.854
Means	3.0215	2.8025	3.0653	2.6701	2.982	3.5401	4.8325	4.1136	2.8865	4.0929	3.7044	3.1752
1772	1.75	4.383	2.059	4.92	2.279	1.807	3.959	6.863	7.648	6.63	3.555	3.022
Total of 23	68.223	66.037	69.496	63.661	67.844	79.697	99.272	97.366	71.15	69.677	85.051	72.876
Means	2.96602	2.8712	3.0214	2.7678	2.9496	3.4651	4.3162	4.2333	3.0935	4.2033	3.697	3.1685
1773	2.788	1.218	2.794	2.312	2.256	1.912	2.731	2.555	2.938	4.009	1.959	5.142
Total of 24	71.011	67.255	72.29	65.973	70.1	81.609	102.003	99.921	74.088	100.686	87.01	78.018
Means	2.9588	2.8022	3.0121	2.74885	2.9208	3.4	4.2501	4.163	[page	torn]	3.6255	3.25075

a very active interest in meteorology. Franklin purchased in England an 8-foot telescope and some other instruments for Professor Winthrop, and the meager correspondence we have deals largely with these matters. In one letter from Franklin to Winthrop, appears this sentence: "I thank you much for the papers and accounts of damage done by lightning, which you have favored me with." Further than this there is nothing of strictly meteorological interest.

GOVERNMENT METEOROLOGICAL WORK IN BRAZIL.[1]

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[*Continued from the Monthly Weather Review, August, 1908.*]

THE DAILY WEATHER MAP AND FORECASTS.

The daily weather map published by the meteorological section of the Navy Department is based on observations made at Greenwich noon ($9^h\ 07^m$ a. m. Rio time) at about forty stations. Most of these are the regular stations of the Navy Department already referred to; some are under the control of the Telegraph Department (e. g., the important one at Curityba), and some are in neighboring foreign countries (e. g., Cordoba, Rosario, Buenos Ayres, Mendoza, Montevideo, and Asuncion). Several reports are missing each day. The despatches are sent by telegraph, in cipher, and include pressure, temperature, vapor tension, mean temperature of the preceding day, cloudiness, wind direction, and wind velocity. It is a serious lack not to have the amounts of precipitation during the preceding twenty-four hours given. These data would be more valuable even than the temperature and at many, if not all, of the reporting stations rain gages are already provided. The information regarding rainfall now included in the daily despatches is limited to such vague generalized statements as the following:

[1] Accompanied by Chart IX.